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# Technical Review Report for the Application for Contents Amendment for Shipping Isentropic Compression Experiment (ICE) Apparatus in 9977 Packaging

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**Technical Review Report  
for the  
Application for Contents Amendment for Shipping  
Isentropic Compression Experiment (ICE) Apparatus  
in 9977 Packaging**

**Revision 2  
February 20, 2009**

LLNL-TR-412981

Docket Number 09-05-9977

February 2009

**Packaging and Transportation Safety Group  
Global Security Principal Directorate  
Lawrence Livermore National Laboratory**

## OVERVIEW

This report documents the review of *Application for Contents Amendment for Shipping Isentropic Compression Experiment (ICE) Apparatus in 9977 Packaging*, prepared by Savannah River Packaging Technology (SRPT) of Savannah River National Laboratory (SRNL) of Savannah River Nuclear Solutions, LLC,<sup>[1]</sup> — the Submittal — at the request of the Department of Energy's (DOE) National Nuclear Security Agency's (NNSA) Albuquerque Facility Operations Division, for the shipment of the ICE apparatus from Los Alamos National Laboratory (LANL), to Sandia National Laboratory (SNL). This Addendum supplements the Safety Analysis Report for Packaging (SARP), Revision 2,<sup>[2]</sup> for the Model 9977 Package and Addendum 1, Revision 2,<sup>[3]</sup> to Revision 2 of the Model 9977 Package SARP. The ICE apparatus is considered as part of Content Envelope C.6, Samples and Sources, under the submittal for the Model 9978 Package SARP currently under review.<sup>[4]</sup>

The Staff at Lawrence Livermore National Laboratory (LLNL) recommends that the Submittal be approved by the DOE-Headquarters Certifying Official (EM-60), and incorporated into a subsequent revision to the current Certificate of Compliance (CoC),<sup>[5]</sup> to the Model 9977-96 Packaging.

# **Technical Review Report for the Application for Contents Amendment for Shipping Isentropic Compression Experiment (ICE) Apparatus in 9977 Packaging**

**Submitted by the  
Packaging and Transportation Safety Group  
Global Security Principal Directorate  
Lawrence Livermore National Laboratory**

**February 2009**

## **Chapter 1: General Information**

This Technical Review Report (TRR) covers the Staff's findings regarding review of the Submittal, *Application for Contents Amendment for Shipping Isentropic Compression Experiment (ICE) Apparatus in 9977 Packaging*.<sup>[1]</sup> This section of the TRR covers the review of the General Information provided in the Submittal. Specifically, the review examined a new content to be shipped in the Model 9977-96 Packaging, the ICE apparatus. The ICE apparatus is considered to be bounded by Addendum Content Envelopes AC.3 and AC.4, plutonium/uranium metals with differing <sup>240</sup>Pu limits for the Model 9977 Package SARP.<sup>[3]</sup> Also, the ICE apparatus is considered part of Content Envelope C.6, Samples and Sources, for the Model 9978 Package SARP, Revision 0.<sup>[4]</sup> However, this SARP is presently in the review process. In order to support the Z Machine ICE program, the ICE apparatus is being added as a Content Envelope to the Model 9977 Package SARP to facilitate shipments from LANL to SNL as that packaging is already certified by EM-60. The Model 9977 Package has a single containment boundary using the six-inch containment vessel (6CV). In contrast, the Model 9978 Package has a single containment boundary using a five-inch containment vessel (5CV).

The ICE apparatus consists of a stainless steel assembly containing about 8 grams of <sup>239</sup>Pu or its dose equivalent as noted in Table 1, *Comparison of 9977 Content C.1 and the ICE Radioactive Contents*, of the Submittal. The ICE target is mounted on the transport container assembly base. A Viton<sup>®</sup> O-ring seals the transport container base to the transport container body. Another Viton<sup>®</sup> O-ring seals the transport container handle to the transport container body. The ICE apparatus weighs less than 30 pounds<sup>[6]</sup> and has less than 0.6 watts decay heat rate. For the Model 9977 Package, the maximum payload weight is 100 pounds and the maximum decay heat rate is 19 watts.<sup>[2]</sup> Thus, the maximum payload weight and the maximum decay heat rate for the Model 9977 Package easily bound those for the ICE apparatus. Figure 4-3, *ICE Configuration in the 9977 (6CV)*, and Figure 4-4, *Required Foam Within Coil Springs (Top Shown, Bottom Similar)*, are reproduced from the document, *9977 Containment Vessel Dynamic Response with ICE Payloads*.<sup>[6]</sup> The Figures show the packaging system, consisting of two spring mounts (6061-T6 aluminum), two springs formed from American Society for Testing and Materials (ASTM) A 288 QQW-470 steel music wire, and two square blocks of foam (Last-A-Foam<sup>®</sup> TF-5070-10 or equivalent) retained within the springs. The springs and blocks alone do not provide adequate damping for vibrations, arising from transportation, and the addition of foam energy-absorbing materials is necessary. In contrast, for the Model 9978 Package, Armaflex SA foam (a nitril-PCV blend) is used to cushion and to center the ICE assembly within the 5CV.<sup>[4]</sup>

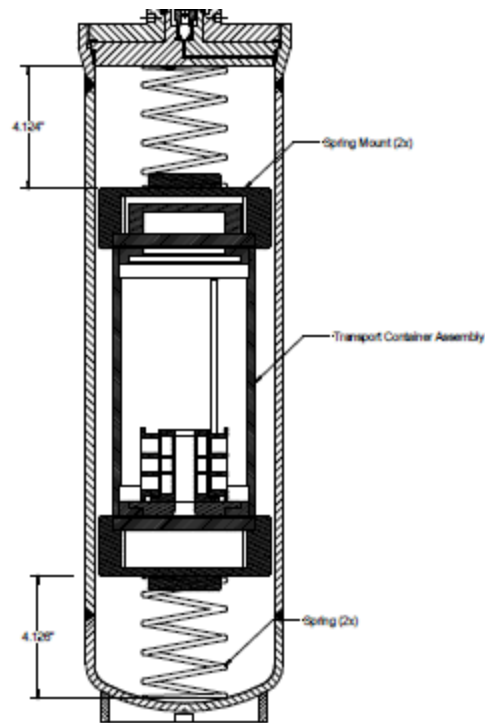


Figure 4-3 ICE Configuration in the 9977 (6CV)

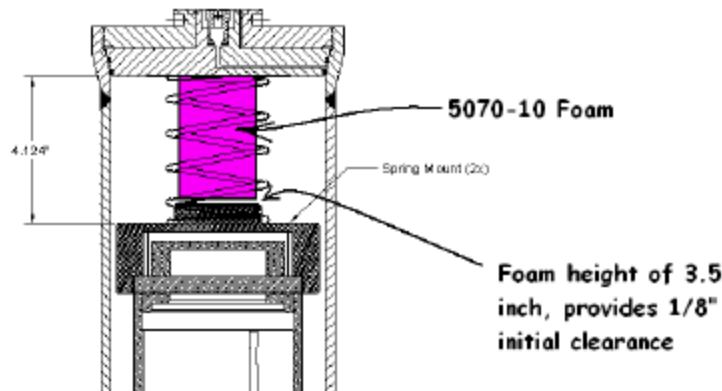


Figure 4-4 Required Foam Within Coil Springs (Top Shown, Bottom Similar)

## Findings

Based on the review of the statements and representations in the Submittal, the Staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.<sup>[7]</sup>

## Conditions of Approval

The Staff has concluded that the following Conditions of Approval need to be added to the existing CoC<sup>[5]</sup> for the approval of this request:

- Application *Table 1-Comparison of 9977 Content C.1 and the ICE Radioactive Contents and Application Table Notes*, and

- Drawings for the ICE Container Assembly<sup>[4]</sup>:  
R83700, *LANL Transport Container Assembly*  
1001-0269-0000, *Platform, Pu Anode, Inner*  
1103-0355-0000, *Panel, ICE, Floor*  
1103-0388-0000, *Panel, 17mm Spacer, ICE*  
1103-0389-0000, *Plug, Panel, 17mm Spacer*  
1350-2333-0000, *Fitting, 1/8 to 1/8, Custom*  
1350-2357-0000, *90° Adaptor Fitting*  
1350-2495-0000, *Probe Nut*  
1350-2496-0000, *Mount, Probe Body, 3-Point*  
R83710, *Transport Container Handle*  
R83711, *Transport Container Anode Mount*  
R83712, *Transport Cannister Body*  
R83722, *Transport Container Strain Relief*  
2-045, *Viton O-Ring*  
502-440-716-AAA2, *Socket Head Cap Screw, alloy steel*  
502-1420-1-AAA2, *Socket Head Cap Screw, alloy steel, and*
- Figure 4-1, *Springs Supporting ICE Transport Container Assembly*<sup>[6]</sup>
- Figure 4-2, *Spring Mount Design*<sup>[6]</sup>

## Chapter 2: Structural Evaluation

This TRR covers the Staff's findings regarding review of the Submittal. This section covers the assessment of the Structural Evaluation information provided in the Submittal.

Details of the ICE assembly review are noted above in Chapter 1. The results of the structural review are discussed below.

### Model 9977 Package with ICE Payload

In agreement with *Application for Contents Amendment for Shipping Isentropic Compression Experiment (ICE) Apparatus in 9977 Packaging*, the Staff has determined that the new ICE payload in the 6CV of the Model 9977 Package will not significantly change the structural performance of the Packaging and its compliance with the requirements of 10 CFR 71. This determination is based on the following considerations:

- The ICE payload configuration will not result in any increased loading of the 6CV's containment boundary above that due to currently-approved contents during NCT.
- The ICE payload is of less mass than currently-approved contents of the 6CV. Therefore, the results of analyses and drop testing on the currently-approved Packaging bound the structural response of the Model 9977 Package with ICE payload for the HAC event.
- The Staff has performed calculations confirming the structural integrity of the 6CV with the ICE payload.

Consequently, no degradation in the structural performance of the Packaging is expected due to the ICE payload.

### **Findings**

The supporting calculations from the applicant<sup>[6]</sup> combined with the confirmatory calculations, performed by the Staff, lead the Staff to conclude that the structural design of the Model 9977 Package with the new (ICE) content payload configuration has been adequately described and evaluated by the applicant.

### **Conditions of Approval**

The Staff has concluded that no additional Conditions of Approval need to be added to the existing CoC for the approval of this request.

## **Chapter 3: Thermal Evaluation**

This TRR covers the Staff's findings regarding review of the Submittal. This section covers the review of the Thermal Evaluation information provided in the Submittal.

Details of the ICE assembly review are noted above in Chapter 1. The results of the thermal review are discussed below.

### **Model 9977 Package with ICE Payload**

The Submittal mentions the contents contain less than 0.6 watts decay heat rate. The Model 9977 Package is limited to 19 watts according to its SARP. Thus, the decay heat rate for the Model 9977 Package easily bounds the decay heat rate for the ICE assembly.

### **Findings**

Based on the review of the statements and representations in the Submittal, the Staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.

### **Conditions of Approval**

The Staff has concluded that no additional Conditions of Approval need to be added to the existing CoC for the approval of this request.

## **Chapter 4: Containment**

This TRR covers the Staff's findings regarding review of the Submittal. This section covers the review of the containment information provided in the Submittal.

Details of the ICE assembly review are noted above in Chapter 1. The results of the containment review are discussed below.

### **Model 9977 Package with ICE Payload**

The containment boundary for the 6CV of the Model 9977 Package is provided by the vessel body weldment, the Cone-Seal Plug, the Leak Test Port Plug, and the outer O-ring. Addition of the ICE assembly does nothing to alter the containment boundary. The ICE assembly has two O-rings, one on the transport container base and one on the transport container handle, as discussed in the General Information Chapter. Inside the ICE assembly, the special nuclear material samples are glued and double sealed inside counterbores machined inside aluminum



panels.<sup>[4]</sup> However, the ICE assembly is similar to a convenience container and is not credited with being part of the containment boundary for the Model 9977 Package.

### **Findings**

Based on the review of the statements and representations in the Submittal, the Staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.

### **Conditions of Approval**

The Staff has concluded that no additional Conditions of Approval need to be added to the existing CoC for the approval of this request.

## **Chapter 5: Shielding Evaluation**

This TRR covers the Staff's findings regarding review of the Submittal. This section covers the review of the Shielding Evaluation information provided in the Submittal.

Details of the ICE assembly review are noted above in Chapter 1. The results of the shielding review are discussed below.

### **Model 9977 Package with ICE Payload**

The ICE contents were evaluated for the Model 9978 Package SARP as a component of Content Envelope C.6, Samples and Sources. Content Envelope C.6 permits a total radioactive mass of 12,750 grams. The shielding analysis for the Model 9978 Package SARP analyzes the contents in the 6-inch diameter containment vessel (6CV) of the Model 9977 Package, as that geometry places the source closer to points of dose rate measurements for compliance. Content Envelope C.6 meets the package surface dose rate limits for 10 CFR 71.47 in the 6CV configuration, therefore, the ICE assembly content also meets these limits.

### **Findings**

Based on the review of the statements and representations in the Submittal, the Staff has concluded that the shielding design has been adequately described and evaluated for the content limits described in Table 1 of the Submittal and that the Package meets the external radiation requirements of 10 CFR 71.

### **Conditions of Approval**

The Staff has concluded that no additional Conditions of Approval need to be added to the existing CoC for the approval of this request.

## **Chapter 6: Criticality Evaluation**

This TRR covers the Staff's findings regarding review of the Submittal. This section covers the review of the Criticality Evaluation information provided in the Submittal.

Details of the ICE assembly review are listed above in Chapter 1. The results of the criticality review are discussed below.

### **Model 9977 Package with ICE Payload**

Table 1 of the Submittal lists the allowable gram quantities of various actinide isotopes for the ICE assembly contents. The gram quantities range from 0.005 for  $^{241}\text{Pu}$  to 8 for  $^{239}\text{Pu}$  and also for  $^{242}\text{Pu}$ . Thus, all these actinide isotopes fall into the fissile exempt category ( $\leq 15$  grams fissile material although  $^{242}\text{Pu}$  is not fissile) of 10 CFR 71.15(b).

### **Findings**

Based on a review of the statements and representations in the Submittal, the Staff has concluded that the nuclear criticality safety design has been adequately described and evaluated, and that the package meets the nuclear criticality safety requirements of 10 CFR 71.

### **Conditions of Approval**

The Staff has concluded that no additional Conditions of Approval need to be added to the existing CoC for the approval of this application.

## **Chapter 7: Operating Procedures**

This TRR covers the Staff's findings regarding review of the Submittal. This section covers the review of the Operating Procedures information in the Submittal.

Details of the ICE assembly review are noted above in Chapter 1. The results of the operating procedures review are discussed below.

### **Model 9977 Package with ICE Payload**

The ICE assembly requires a set of spring mounts, a set of springs, and a set of square blocks of foam, retained within the springs, in order to achieve adequate damping of vibrations during transportation in the 6CV for the Model 9977 Package.<sup>[6]</sup> However, the ICE assembly has to be an approved content configuration per Section 7.1.1.2, *Contents/Payload Preparation*, of the Model 9977 Package SARP in order to be loaded into that Packaging, so, there are no changes to Chapter 7 of the Model 9977 SARP.

### **Findings**

Based on the review of the statements and representations in the Submittal, the Staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.

### **Conditions of Approval**

The Staff has concluded that no additional Conditions of Approval need to be added to the existing CoC for the approval of this request.

## **Chapter 8: Acceptance Tests and Maintenance Program**

This TRR covers the Staff's findings regarding review of the Submittal. This section covers the review of the Acceptance Tests and Maintenance Program information provided in the Submittal.

Details of the ICE assembly review are noted above in Chapter 1. The results of the acceptance tests and maintenance review are discussed below.

### **Model 9977 Package with ICE Payload**

There are no additional acceptance tests and maintenance program requirements specific to the ICE assembly for shipment in the 6CV of the Model 9977 Package. Therefore, the new configuration has no impact on Acceptance Tests or Maintenance Program for the Model 9977 Package.

### **Findings**

Based on the review of the statements and representations in the Submittal, the Staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.

### **Conditions of Approval**

The Staff has concluded that no additional Conditions of Approval need to be added to the existing CoC for the approval of this request.

## **Chapter 9: Quality Assurance**

This TRR covers the Staff's findings regarding review of the Submittal. This section covers the review of the Quality Assurance (QA) program description and packaging-specific QA requirements provided in the Submittal.

Details of the items reviewed are noted above in Chapter 1. The results of the quality assurance review are discussed below.

### **Model 9977 Package with ICE Payload**

Addition of the ICE payload to the Model 9977 Package represents no additional Quality Assurance requirements. The ICE payload is bounded by the baseline content configuration, the 100-pound slug, used for the both Normal Conditions of Transport and Hypothetical Accident Conditions for the Model 9977 Package.

### **Findings**

Based on review of the statements and representations in the Submittal, the Staff concludes the QA program has been adequately described and meets the QA requirements of 10 CFR 71, Subpart H.

### **Conditions of Approval**

The Staff has concluded that no additional Conditions of Approval need to be added to the existing CoC for the approval of this request.

## References

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- [1] *Application for Contents Amendment for Shipping Isentropic Compression Experiment (ICE) Apparatus in 9977 Packaging*, National Nuclear Security Administration Memorandum from Paul T. Mann, Facility Operations Division, NA-172.1, to James M. Shuler, Office of Packaging and Transportation Safety, EM-63, Revision 2, February 20, 2009.
- [2] *Safety Analysis Report for Packaging-Model 9977*, Savannah River Packaging Technology, Savannah River National Laboratory, S-SARP-G-00001, Revision 2 (August 2007).
- [3] *Safety Analysis for Packaging, Model 9977, Addendum 1, Justification for DNDO Contents*, Savannah River Packaging Technology, Savannah River National Laboratory, S-SARA-G-00003, Revision 2 (October 2008).
- [4] *Safety Analysis Report for Packaging, Model 9978*, Savannah River Packaging Technology, Savannah River National Laboratory, S-SARP-G-00002, Revision 0 (December 2007).
- [5] USA/9977/B(M)F-96 (DOE), *U.S. Department of Energy Certificate of Compliance for Radioactive Materials Packages, Model 9977*, Rev. 1, U.S. Department of Energy, Washington, D.C, January 8, 2009.
- [6] *9977 Containment Vessel Dynamic Response with ICE Payloads*, Savannah River National Laboratory, M-CLC-A-00355, Revision 0, Charles McKeel, February 3, 2009.
- [7] Nuclear Regulatory Commission, 10 CFR Part 71, *Compatibility with IAEA Transportation Standards (TS-R-1) and Other Transportation Safety Amendments; Final Rule*, 69 F.R. 3698, pp. 3698–3814, January 26, 2004, as amended.